

Transactions of The Chartered Surveyors' Institution

SESSION 1936-1937.

AT THE ORDINARY GENERAL MEETING

*Held at the Chartered Surveyors' Institution, Monday,
11th January, 1937.*

Mr. J. M. THEOBALD (President) in the Chair.

NEW MEMBERS.

The following new members were received by the
PRESIDENT prior to the meeting and signed the Register:—

Professional Associates :

BEESLEY, GORDON WELLESLEY	HUMPHERY, RONALD SYLVESTER
VICARS	MUTFORD
BERRY ROGER SEAGER	JARVIS, FRANK E.
BETTS, HENRY FENNELL	LANGLEY-SMITH, ALEC FREDERICK
BROOMHALL, PAUL JOHN	COLINGWOOD
BURTON, REGINALD RICHARD	OWEN, RICHARD LANCELOT
CLARKE, ALAN NEWTON	SHEARS, HAROLD SCIVIER
CUSACK, WILFRID GUY	SMITH, GEOFFREY HANSON
ELLIOTT, KENNETH FRANK	TILLYARD, WALTER JAMES
EDIS, CHARLES VESSEY	FREDERIC
	WAKEFIELD, VICTOR HUGH

A DISCUSSION took place on Major NELSON ROOKE'S paper entitled

**THE NATION'S FOOD SUPPLIES IN RELATION TO
DEFENCE.**

Mr. FRANCIS PETER (Member of Council) proposed a vote of thanks to Major Nelson Rooke on the presentation of a paper of national importance. So long as fear was riding unchecked throughout Europe, such a question as was dealt with in the paper must be of serious import and interest to every one of the 9,000 members of the Institution and to the whole community. Major Rooke was to be congratulated not only on the ability which was obvious from his paper, but on the industry which he had shown in marshalling the pertinent extracts from past and present literature and making it quite clear to his audience that the deductions at which he had arrived were sound.

The main theme of the paper was a plea for greater production, and everyone present would be in full sympathy with that plea. It was obvious, however, that, under any given national conditions, the margin of economic production was a very small one, and with profits in agriculture, if any, almost invisible to the naked eye, there was very little margin on which the producer could launch out on new improvements.

The direct route to increased production was, of course, more profitable production, but without some increase in prices he had little hope of that coming about. Here, again, the margin was a very small one, unless, of course, the general improvement in trade also assisted agricultural prices. The trouble seemed to be that the public, although they more or less willingly subscribed to armaments, were not so willing to pay an increased price for foodstuffs over an indefinite period in order to provide a premium of insurance against emergency. Those facts were well known both to speakers and writers on agricultural subjects, and one always found that they left it to the Government to frame a policy, and the Government could not frame a policy which, up to the present at any rate, had been effective. The remedy might lie in the same direction as the remedy for agriculture itself, namely, in a multiplicity of small things, and therefore he was very much in agreement with Major Rooke that the matter should be dealt with at once.

The main line of investigation seemed to be the absorption of surpluses, and he was fully convinced that the remedy was that suggested by Sir John Orr. There was an immense potential consumption if the difficulty of distribution could be overcome. Sir John Orr had made reference to the fact that services might be divorced from goods. He thought that was not so easy ; there was practically a " Roman Catholic attachment " between these two. What was still more serious was that the consumer was always asking for greater services instead of less, and the consequence was that overhead charges to the retailer were going up by leaps and bounds, requiring new accommodation and a re-arrangement of delivery systems to fit in with telephone shopping. He did not think it should be an insuperable difficulty, however, to provide healthful food to those who needed it most, and that was the point which should be stressed so far as the Government was concerned.

In the case of wheat the important point was storage. He did not agree with Major Rooke in his proposals to keep wheat in stack ; that would be inadvisable in view of the millions of rats and mice in this country. Nor did he quite agree with Major Rooke in his apportionment of the quota, but it would have this effect, that the dilatory farmer would hurry up with his spring cultivations in order to start threshing on 1st April.

With regard to livestock, he hoped that something would be done to improve the beef trade. If that came about, the milk trade would settle itself, and the balances of agriculture be adjusted without further difficulty. He could not see the use of taking the cattle to central abattoirs, involving the necessity of the meat going into cold storage and coming in competition with the best foreign meat. Already cattle were being moved about far too much, bearing in mind that their customers were at their doors.

If the Services and institutions and any bodies which consumed large joints of meat could be persuaded to deal with English meat a demand would arise for heavy cattle and two-year old sheep which would form a most useful reserve in time of emergency.

In the case of pigs, those were rather looked upon as potential bacon, and there was a tendency to forget that a large part of the pig population, above and below the bacon weights, were the most profitable part of the family, and he thought if the " cutter " trade—a trade term which would be understood—was sacrificed to the bacon trade, it would be a bad thing for the smallholder and small farmer who produced an immense number of pigs in this country, and at a profit.

Major Rooke had referred to grass-drying, and the speaker believed there was a great future for that. The reason why he liked the idea so much was that feeding-stuffs were now running a close second to labour in absorbing farm profits, and if some of those feeding-stuffs could be produced at home in time of war it would be of tremendous benefit.

With regard to credit, he liked a farmer who could work on his own capital. If he could not do that, he had a very rough time indeed. But he wondered why so many farmers were still prepared to pay $5\frac{1}{2}$ to 6 per cent. on their mortgages. The National Farmers' Union might do a great deal for its members in that respect and save a few millions to agriculture.

The question of storage was one of importance. Wheat was the commodity for which storage must be found, and no amount of additional production would help in that respect. The other matter was whether anything could be done, as Major Rooke had suggested, to encourage both retailers and wholesalers to hold larger stocks of canned meats and other goods of that kind. There was a tendency to-day to work on much smaller stocks than a few years ago. But the thing that did appeal to him more than anything else in the way of storage was the storage of fertility in the land of this country. That would be not only a national asset but a balance which could be drawn upon in time of emergency. What was wanted was three L's—more labour, more live-stock and more lime. One could see innumerable ways by which production could be increased, especially with financial assistance, but it was not so easy to visualise the organisation by which that could be done. Not too much was wanted of what the Chairman of the National Farmers' Union once described in that room as "a measure of control." It was necessary to be very careful what control they got, and bearing in mind the sort of people one found on the land, he felt sure more would be done through local effort by county agricultural committees supervised by some central body than by any other means.

So far as the Institution was concerned, there was a great work before it, and it could take a very active part in bringing into effect the suggestions which had been put forward by Major Rooke. On looking at the Table prepared by Major Rooke—and a very useful Table it was—he was afraid his sympathies were very much with the gentleman who was to be Minister for the Co-ordination of Defence. From that Table he appeared to be occupying a very exalted position, on the very summit of what was rather suggestive of a Tower of Babel. He would ask Major Rooke only one question, and he would not expect an answer from him that evening. Bearing in mind the importance of the

subject he had dealt with, what were his views on Section 12 of the Agricultural Holdings Act?

The Institution owed Major Rooke a great deal for preparing his exhaustive paper, which would be of the greatest interest when it was read over again more carefully at their leisure.

Mr. A. J. BURROWS (Chartered Surveyor), in seconding the vote of thanks to Major Rooke, said that it was a most admirable paper, packed with information throughout, and he hoped it would receive the great publicity which it deserved as a contribution towards the preparations for national defence. Every land agent and surveyor would agree that a great deal more food could be produced from the soil of this country if the facts were faced and if the urban population were made to realise the position. Major Rooke had already quoted the optimistic report of the Cabinet in 1917. He need not repeat that, for most of it had fallen to the ground, and the guaranteed prices were very soon abandoned. Since 1866, which was the first year of reliable records, until the present year arable land had decreased by 5 million acres. Major Rooke had quoted Lord Ernle as saying 100 acres of arable would support 135 more people than 100 acres of grass. Basing a calculation on that, it would be found that 6,750,000 people could have been supported on that 5 million acres if it had not been laid down to grass.

He agreed with the Table of minimum or guaranteed prices which Major Rooke had laid down. He thought they were very reasonable and fair, but he wished to add one important commodity, at least to certain parts of the country, namely, wool.

Major Rooke had stressed the importance of the Food Production Department, and there he entirely agreed with him. He supposed that they would all consider that in the long run no crop would continue to be produced unless it was remunerative, no matter whether it was meat, grain, or anything else. Therefore it was necessary to establish remunerative prices. How was that to be done? He supposed by the same way as had been done in the case of wheat, where they had a system of quotas and levies. Major Rooke had stated that that had been effective so far in the case of wheat. It had had remarkable effects in the case of sugar beet, and it had also increased the production of milk and of beef.

The author of the paper had alluded to the possible clamour if prices were increased, and he supposed that the old cry would be heard again, "Hands off the people's food." But he ventured to suggest that the question might well be put to the working classes whether they would prefer safe food or cheap but uncertain food. The trouble with agriculture was that it was the only

industry in which wages had been fixed by statute. If wages had been fixed, why should not prices be fixed? If prosperity were secured for agriculture, capital would begin to flow into it. Investors, capitalists and corporate bodies were turning their attention to land more and more. They had in fact bought large areas of land, and those investors and capitalists might be relied upon to carry out a great deal in the way of permanent improvements. But there was a great deal of under-cultivation in this country; every land agent knew that a great deal of cultivation was very low. Professor Stapledon had stated that 43 per cent. of the land was under-cultivated. That was a very serious thing. How was that cultivation to be improved? There were owners in the fortunate position of being able to take a derelict farm in hand, re-condition it, get it into cultivation, put it in repair, manure the land, and after a few years relet it to a more satisfactory tenant. But many landowners were not in that position. What was to be done? In the War, if a notoriously inefficient farmer were discovered, he was turned out and his land handed over to somebody who would cultivate it properly. Was it not better to do that now rather than leave it until the outbreak of war? Would it not be better to get the land into cultivation instead of waiting for an emergency? There were, unfortunately, a large number of unemployed—he believed over one million men, apart from women and children. Was it not possible to get some of those unemployed to work on the land? Many of them would be glad to get employment, for they were deteriorating physically and mentally without it. Would it not be possible in the case of neglected farms to assign a quota of those unemployed men to each farm? He noticed that in one case two men for every hundred acres had been suggested. The men could be taken by the farmer and billeted in his own cottages or in the villages very much in the same way as German prisoners in the War. Those men should be put, not on ordinary farming work, but on improvements and re-conditioning of the land. Somebody should be required to keep a wages sheet showing exactly what those men were doing every day to make sure that they were not employed on ordinary agricultural work. He knew that such a system would be liable to abuses, and would appear to be putting a premium on a slovenly farmer; but was not it better to get the national heritage into good condition, even if it cost something, rather than pay the dole for nothing? The farmer who employed those men should be liable to pay them one-third or one-half of the dole. Thus not only would the nation be getting some necessary work done, but some of the money spent on the dole would be returned. He merely put forward that suggestion as a ninepin which somebody else might knock over.

Systems of farming might have to be largely modified. Possibly it might be necessary to go in for a system of alternate husbandry which had been successful in many ways ; the grass land had to be looked after. They did not really cultivate their grass land, but let it take its chance. He thought that wheat had perhaps been unduly emphasised. It formed only a relatively small part of the production of many farms, and he ventured to plead for a more balanced system of increased production. He wished to emphasise the importance of potatoes, which afforded a very large amount of food per acre. Then there were pigs and poultry, which reproduced very rapidly indeed and might have increased attention. With regard to milk, at the moment there were great difficulties, but there was no more valuable food.

The question of tinned food had been raised. Many of them often went to a country cottage and, looking at the back garden, saw a heap of rubbish, including a large number of tins which had held salmon, lobster, beef, tongue, condensed milk and produce of that kind. If the poorer classes of the population knew the value of the cheaper joints of meat, a great deal of that meat would be used instead of those tinned foods, which could not be so wholesome, and home production encouraged. One of the great difficulties in the agricultural labourer's house was the poor facilities for cooking. The only fire in the cottage had to do the cooking, warm the house and dry the clothes, and probably the grate was very much out of order. When electricity became more universally distributed, very much greater facilities would be afforded in that way. He knew some cottages where it had been possible to instal electric cooking, and their occupants were very pleased indeed. One of his own men told him that he did not think it cost him more in the year than the coal used to cost, and in respect of convenience and cleanliness there was, of course, no comparison.

Another thing to think about was the rabbit menace. In some parts of the country rabbits had increased enormously and were doing an immense amount of damage, with which there seemed no efficient way of coping. The farmer had the right to kill rabbits and hares on his own land, but if his land was up against or between big woods, that was quite ineffective. Legislation would be necessary to control the rabbit question.

He wished now to allude to another country. An old Latin proverb ran: "*Fas est et ab hoste doceri*" ("It is well to be taught even by an enemy"). He wanted to allude to what had been done by a former enemy, Germany. A very interesting and valuable report had been published on "Economic Conditions in Germany," written up to March, 1936, by the Commercial Counsellor to His Majesty's Embassy in Berlin. It was published

by the Stationery Office, and deserved very careful study. The opening statement read: "National Socialist Germany's policy in regard to the natural resources of her territory is determined on the one hand by the axiom that the rural population is the backbone of the nation and, on the other, by the pursuit of national economic self-sufficiency as an ideal." Then it went on to say that agriculture in Germany had set itself to engage in a "Battle of Production" (those were the actual words of the report) in which "pressure for, and progress towards, such self-sufficiency are in striking evidence." The report stated that that policy had been so successful that, whereas in 1927 one German in every three was fed on imported food, by the end of 1935 only one German in five was so fed. Germany was now able to produce on her own territory 80 per cent. of the total food used in the year by her population of 66 millions. In 1924 the production of home-grown wheat in Germany was 49 per cent. of total requirements, but by the end of 1934 it had risen to 93·5 per cent., and he had no doubt that by the end of 1936 it would have risen higher still. The yield per acre of her other food crops had been materially increased. She had also increased her livestock and milk production very largely. Electricity was very widely distributed in Germany. Four out of five German farmers had access to electric light and power, and two out of every five had electric motors in operation, while two-thirds of German threshing was done electrically, and much other machinery was electrically driven. Of course Germany was under a dictator, and agriculture was very strongly controlled. A system of that kind was not possible in this country under present conditions, but he would suggest that it showed what could be done by attention to the resources of their own country, because he did not think the climate or conditions or soil in Germany was any better than, if as good as, those in this country.

In England and Wales in 1924 the production of home-grown wheat was 17·6 per cent. of the total requirements, and by 1934 it had risen only to 24·4 per cent., as against 93 per cent. in Germany. He thought that those figures were very suggestive, and he urged those present to obtain and read that interesting report.

Consideration ought also to be given to the question whether it should not be the duty of every owner and every occupier of land in this country to use it to the best advantage for the national welfare. There would have to be proper safeguards, of course, as to amenities and in many other directions, but it should be considered very seriously whether some sort of legislative enactment might not be provided whereby every owner and occupier

would be bound to use his land for the best advantage of the community.

Major Rooke had alluded to the question of storage, and he agreed with him as to the advantage of underground storage where that could be arranged. He agreed also with the last speaker that storage in stacks for any length of time was rather difficult. If he went on a farm and saw a stack standing until the spring it was generally found riddled with rats and mice, with very considerable loss.

As to smallholdings, he had always been a great advocate of those, provided the right man—the country-bred man—was put upon them. The men who should be encouraged to take smallholdings were the thrifty agricultural labourer, or the foreman or bailiff. Those men should have an opportunity by assistance of eventually obtaining a little holding of their own. Agricultural labour, instead of being a sort of blind end, should offer an opportunity to that sort of man to obtain a little holding of his own. The holding might only be a part-time occupation, but it would tend to greater stability in this country.

He also advocated allotments, especially in the outskirts of urban districts, because a great deal of food for a family could be produced on a proper allotment.

Finally, he referred to the Channel Tunnel, a project which was turned down in 1930 on economic, engineering and military grounds. Those objections might still hold good, but he threw out the idea that if the Channel Tunnel were practicable it would furnish in emergency greatly extended sources of supply, not only from vast territories, but from many other ports than their own. Of course the idea might be Utopian, but as a man in the street it did not seem to him that there would be any great difficulty in defending the Channel Tunnel.

He concluded by most heartily seconding the vote of thanks.

Mr. FRANK J. TRUMPER, F.L.A.S. (Professional Associate Member of Council) (Chairman, Junior Organisation), wished to compliment Major Rooke on the courageous way he had undertaken his task. He thought the answer to the problem was that agriculture must be subsidised with the object of increasing supplies. In order to do that the farmer and the farm labourer must be encouraged. The farmer was no fool; if he got a good price for his produce he would grow more. The labourer also must not be forgotten. It was most distressing that only perhaps one in ten or twelve farm labourers were young men; most farm labourers were over 50. It was an industry into which they must attract young men, giving them wages which would rival in pur-

chasing power the wages of the urban worker. Young men were not going to be attracted into agriculture unless their remuneration was on a par with that of the industrial worker. That brought one up against a considerable problem, but the situation in which the nation found itself was an extremely serious one, and only a bold policy would bring them through. It was of no use playing about with the matter. There was no need for him to go into details, but he instanced the beef proposals. For a nation suffering under present disabilities, it was nothing less than an insult to expect farmers to produce beef at those prices.

The question of the cost of living had been raised. Much was said about cost of living but not much about the purchasing power of the pound, which had progressively decreased in the course of centuries. It was safe to say that, although the pound purchased less to-day than it did even before the War, a much smaller proportion of the wages of the worker was spent on food. That proportion might well be increased. The workers had much more money to spend on luxuries, and there was a margin which would well meet an increase in cost of living which must necessarily arise if an adequate national policy were pursued. It was of no use saying that no Government dare take action which would have the effect of raising the cost of living. If it was known to be the right course to take this action, the question could not be baulked in present circumstances.

As a young man it gave him great pleasure to speak on this subject, though he did so with some diffidence. The problem was essentially one for younger men. Their heritage was at stake. It was a subject very close to his own heart, and he thought it should be close to the heart of every young man in this country. There existed in the Chartered Surveyors' Institution and the Land Agents' Society an enormous fund of experience of senior people who had been through it all before, while the younger men had both enthusiasm and ability; he hoped Government departments would believe him when he said that that experience and energy was at their disposal.

He would not enter into the details of the paper, but he spoke rather on broad principles. He had been a little disappointed that the paper should have been entitled "The Nation's Food Supplies 'in Relation to Defence.'" It really meant in time of war. It reminded him of the pusillanimous attitude adopted by many territorial commanding officers who, in order to encourage recruiting and to conciliate pacifists, used the motto "Defence 'not defiance.'" He had no use for anybody who said "I would 'not be in Sir Thomas Inskip's shoes at this moment.'" As Minister for the Co-ordination of Defence Sir Thomas Inskip had

the whole nation behind him. He had unlimited resources to meet a vital and urgent need. Anybody who had the sense of his country's heritage at heart would be proud to be in that position. Anybody with "guts" would be pleased to occupy it.

He wished the Minister success, and hoped advantage would be taken of the facilities afforded by the professional societies to solve this urgent problem.

Dr. CLOUDESLEY BRERETON, M.A. (Visitor), who said that he had written seventeen articles on this subject and had distributed some 60,000 pamphlets, declared his full agreement with Major Rooke that the core of the problem lay, not in the rationing of food, but in the production of more food and its production at once. The record of the Government in that respect, as he had shown in an article in *The Fortnightly* of the present month, was quite unsatisfactory. The Government had had a whole year to consider this subject, as it had had a year to consider the needs of the Services, and all it had done was to appoint one Committee after another, the Committees treading on each other's tails, the result being a regular jig-saw puzzle of Committees, and then the Government said that, after all, the future of the production of food would remain with the Minister of Agriculture.

Those old shibboleths "Your food will cost you more" and "The consumer will always have to pay the duty that is imposed" were the chief obstructions to expanding and protecting home supplies. He had had a controversy on that subject in a Free Trade journal, and was so satisfied with its conclusions that he republished it in the form of a pamphlet, proving his points to his own satisfaction and, after all, what more satisfaction was ever got out of controversy? If there were two markets and the entry of some commodity into one of them was governed by 10 per cent. duty and into the other by a 30 per cent. duty, and the duty in the first instance was raised from 10 to 25 per cent., that particular commodity would still have to go into that particular market rather than into any other. The people abroad who were producing that particular commodity would still send it to this country despite the higher duty because no where else could they send it more cheaply.

Quite recently this question came forward in a practical way in the Argentine. When it was stated that there was a possibility of $\frac{3}{4}d.$ a pound coming on to beef imported into this country, the meat producers declared that they would have to pay the whole of the duty. The Argentine Government had since actually made a grant of one million pounds to those people who were

exporting beef to England. Therefore it was evident that the consumer did not pay, and there was no need to be afraid of that outworn shibboleth.

The question of the value of the home market had, he thought, been entirely ignored by the political economists, who had been living on the doctrines of their predecessors for the last fifty years. Those people were to-day quite remote from actuality. The only people who knew the truth about political economy were people like himself and those whom he was addressing who knew where the shoe pinched. Under the old Free Trade ideas people were all supposed to buy what it was most advantageous for them to buy from anybody else and so lived by taking in each other's washing. That theory was no longer tenable, because all countries, increasingly during the last thirty years, had gone in for a self-sufficing policy, for which there was a great deal to be said. Germany had followed that policy with great success. Germany also looked on political economy as the science of national welfare as well as of national wealth. Thus it was a question of rationalisation in Germany, the question was considered from the point of view of the locality, and although in theory it might be advantageous for a particular works to close down, that was not allowed if it meant an enormous difference to the locality, however much the proceedings might enrich a few important people at the top. Suppose there was a little town in this country which paid wages to the amount of £1,000 a week. If such works were closed down the whole of that area was depressed, whatever gain there might be to the nation as a whole. It was of no use telling him that because those works had been moved to Birmingham, or somewhere else, the country was prospering. It might be prospering, but as there were fifty-two counties in England he was sharing in only one fifty-second part of that prosperity instead of getting the lion's share of it, supposing the works were situated in a county like Norfolk in which he lived.

There existed a "Black Pact" with Denmark, one of those things which he regarded as belonging to the category of "nine-pence for fourpence"—they sold fourpence worth of goods and Denmark sold ninepence. That used to be defended on the principle that the money came back to them. The money did not come back. Germany, which did a large trade with Denmark, only did it on a "pound for pound" basis. The money went into a condition which was called "frozen credit," and never came back, or one might have the state of affairs which existed in Nicaragua at the present time, where they were simply overwhelmed with the amount of machinery they had received for

their coffee, the only coin in which Germany could pay them, and did not know what to do with it.

Finally, much had been said about keeping wheat in stack, and it was thought that that subjected it to the ravages of rats and mice. By putting a certain amount of wire around his stacks he had succeeded in completely preventing those depredations ; only a few rats got in, and those were exterminated by means of poison, and when he came to thresh those stacks there were practically no rats at all. He did not think there was any great difficulty in that respect. He had talked it over with a number of farmers in Norfolk and all were of the same opinion as himself.

Captain C. H. SMITH, F.L.A.S. (Fellow), expressed his congratulations to Major Rooke on a paper which he hoped would go further than that Institution, and would be read by some of those in authority in this country. One important question on which Major Rooke had touched was that of a levy on imports. He hoped it might be possible for something on those lines to be adopted. If legislation could be brought forward in that way it might be a means of helping very considerably the agricultural industry.

With regard to the condition of the land, attention had to be drawn to the enormous alteration that had taken place in land tenure during recent years. In 1914 most of the great landholders were still holding their land, and no doubt they could assist materially in benefiting their land through their tenants. That had all passed away. Thousands of acres had now gone over to owner-occupiers, and it was that land which was going back so badly—at least that was his experience in his own part of the country. Where landowners still retained their estates, land agents were able to assist them to the benefit of the land ; but where farmers had become landowners, there was no such help unless it came directly from Government assistance.

Mr. Burrows had referred to the bad cooking facilities in cottages and the consequent use of tinned foods. He himself thought it was the laziness of housewives which led to the use of so much tinned products. They would not take the trouble to cook the food, and consequently the tinned food had come to have an enormous vogue.

Mr. H. BRIAN EVE (Professional Associate Member of Council) (Secretary of the Junior Organisation) said that in the newspapers that evening it was announced that a motion had been put down by the Member for West Norfolk asking the Government to create

a National Food Production Council. That was a point which had been pressed by the author of the present paper, and he thought the Institution might well support that motion in Parliament in some way or other.

The bringing of food to the community seemed to fall into three provinces. There was the producer at one end, the consumer at the other, and the retailer in between. A great deal had been heard about the stimulation of the production of food, but it was of no use producing food if an outlet could not be found for it. Production was not a measure of prosperity, otherwise the film industry in this country would be amazingly prosperous, for many films were being produced here, but there did not appear to be a market for them. It was not enough to stimulate the production of agricultural foodstuffs unless it was ensured that somebody was going to buy them. The consumer was considered because every Government was afraid of increasing the price of food, and while wishing to give the farmer more money for his products, tried to ensure at the same time that the purchaser should not have to pay more for the article. Nothing, however, seemed to be done about the retailer. One or two speakers had said that the prime necessity was to get the urban population to realise the importance of the problem. Some of those present might have seen a recent account of an investigation into the workings of the National Mark system for agricultural products. The investigation was carried out in specimen towns and districts, but the majority of the towns had never heard of the National Mark, and the majority of the consumers had never heard of it. The attitude shown by the average consumer was summed up in the words of one housewife, who said that she trusted her retailer to send her the right kind of stuff and left it at that. She made no specification as to what she wanted. That meant that enormous influence lay with the retailer, everything was left to his discretion, and he was at liberty to supply goods that came from anywhere instead of using his influence to supply goods produced at home. He could not imagine that same housewife leaving it to her dressmaker to send up the evening frock of her (the dressmaker's) own choice. She would pay far more attention to the choice of a frock than she would to the choice of foodstuffs for herself and her family. In the latter respect she was content to let the retailer do the choosing for her, and the retailer far too often chose the foreign produce. He asked whether something could not be done to educate the public and compel the attention of the retailer to the true state of affairs. The attention and care which the average housewife devoted to the outer woman should also be devoted to the inner man.

Mr. C. B. GREENING (Visitor), after expressing his appreciation of the interesting paper, questioned whether Major Rooke had come to the best practical conclusion when he suggested another Food Production Department actually to carry out this all-important task. There were too many State departments already. There was a Food Production Department in the Great War, and the suggestion was now to have another State department for the purpose. Personally he was not sure that that was the right or direct way of approaching the problem. A State department could only do what it was empowered to do by legislation, whereas a business corporation could do anything so long as it kept within its articles of association. Therefore it was the common experience that the activities of every State department was very much limited and sometimes complicated by what was generally called "red tape," an extremely expensive way of carrying out any activity whatever. Personally he would rather see this all-important job started in each county by a business "Agricultural and Food Corporation." Not to make any invidious distinction between the quarters of the compass, he took a county in the very centre of England, namely, Warwickshire. In that county there might be formed the "Warwickshire Agricultural Union," which would own land and produce food, have its food factories, and sell the food produced. The board of directors would include Warwickshire landowners, farmers and business men and bankers. The result would be to organise the production of food and the economic distribution of food in a business organisation to carry out what was essentially a business job. A central organisation would be in existence in London to link up the county organisations. Thus one would have a complete business whole carrying out a national policy by subscribed capital instead of a State department with all that that involved.

Sir CHARLES HOWELL THOMAS, K.C.B., K.C.M.G. (Honorary Member), said that he joined most heartily and without reserve in the expressions of appreciation and gratitude to Major Rooke for the thought he had devoted to the preparation of his paper, and the valuable contribution he had made to the *Transactions* of the Institution. Of course, as had been said by Major Nelson Rooke and by so many speakers, the question of stimulation of production depended almost entirely upon price, or rather upon the return to the producer, which might or might not be the same thing. In dealing with the stimulation of wheat production, Major Nelson Rooke, in his paper, made a suggestion that there would be a national advantage in payments out of the Wheat

Fund being weighted in favour of those farmers who kept their wheat longest in stack. A certain amount of criticism had been made as to the details of that suggestion. There was one fact in that connection which he desired to mention. They were now witnessing a rise in price-levels in some commodities. He believed he was right in saying that wheat of millable quality, home-grown, was sold in Chelmsford the previous week at 46s. a quarter. The standard price under the Wheat Act, which was the basis of contributions to the Wheat Fund, was, although it was limited to six million quarters, based on 45s. a quarter. Thus it was possible that during the present wheat year there might be little or even no payment to be made out of the Wheat Fund. Such a rise in the price, if maintained, might have the effect of rendering impracticable that particular suggestion ; but after all, that was really a matter of detail, and he wanted, once again, to say how much he appreciated the paper and how heartily he supported the vote of thanks to Major Nelson Rooke.

The PRESIDENT said that on behalf of the Council he desired to add his tribute of praise for one of the most interesting papers he had ever read on a subject, about which, as a London quantity surveyor, he knew nothing at all. Major Rooke had spoken on a subject much to the fore, though not so much to the fore as it should be. It was no good mincing matters. There must be no muddling through it in the next war, as the War of 1914-18 was muddled through. Modern war conditions would never allow of that. Having said that, he put the vote of thanks to the meeting.

The vote of thanks was accorded by acclamation, and Major Rooke expressed his acknowledgments.

PAPER 574.

REVISION OF ORDNANCE SURVEY 25-INCH PLANS FROM AIR PHOTOGRAPHS.

By Major R. LI. Brown, R.E.

*Paper to be read at the Ordinary General Meeting of the
Chartered Surveyors' Institution on Monday, 8th
February, 1937.*

It is not easy in a paper of this kind to be fully intelligible without the aid of diagrams and illustrations. I hope, however, that what follows may prove to be clear to those who have some acquaintance with the subject, and sufficiently explicit and interesting to those who have not studied the subject in any detail. I shall show a number of lantern slides when I present this paper at the Institution on the 8th February, and these should make clear any points which may not be so easily appreciated from the written word, and should also be of general interest.

Surveying from air photographs, though still a comparatively young science, is now old enough to have something of a history. It has perhaps already passed its years of adolescence, and is at last beginning to be allowed to get its teeth into a man-sized job of work. It is certainly a lusty youth, but much remains to be done, much experience to be gained, and many feats of valour performed before its potentialities will be generally realised and its power recognised. Like any other promising young man it must win its spurs, which indeed it is doing faster than might have been thought possible; but one thing must be said at once; it is an ally of the other branches of survey, and in

no way competitive with them. As a younger member of the fraternity, it is natural that it should be looked upon with some suspicion and considerable interest. It is right, too, that it should be made to prove its own worth. Like other new inventions whose appearance has at first been mistrusted, it will not displace labour, but by making possible productions which would otherwise be out of the question or uneconomical, it is safe to forecast that it will increase demand, and so increase employment, not only for itself, but also for others. One has only to look at the world map of survey progress, and to remember that as soon as a map is made it commences to need revision, to realise how untenable is any contrary opinion.

THE FLYING PROBLEM.

The problem of flying the aircraft, the platform upon which the camera is mounted, varies with the scale of mapping, with the country to be surveyed, and with the type of photograph required. Stated in general terms, it is the art of bringing the aircraft into the positions from which the photographs must be taken and maintaining a steady platform for the camera. In vertical photography this resolves itself into flying the aircraft along a number of parallel and pre-arranged ground tracks, and maintaining the aircraft on an even keel at a constant height while the photographs are being taken. It is relevant, therefore, to inquire what are the particular photographic requirements for the revision of the Ordnance Survey 25-in. plans by the technique at present in use. Briefly stated, these requirements, the reasons for which will be explained later, are as follows:—

- (1) Scale 1/5,000.
- (2) Narrow angle, long focus length lens.
- (3) 60 per cent. fore and aft overlap between successive photographs.

- (4) Not less than 10 per cent. lateral overlap between adjacent strips of photography.
- (5) Vertical photographs.

The first two of these conditions determine the height at which the aircraft must be flown. The third, though usually only a photographic problem, under these conditions is largely dependent upon the steadiness of the aircraft. The fourth is mainly a problem of navigation, and is similarly very dependent on the steadiness of the aircraft. The fifth is dependent upon the manipulation of the controls of the aircraft immediately prior to and during the instant of photographic exposure ; as exposures take place every five or six seconds, careful manipulation must be exercised during the whole of the photographic run. This requirement itself is of paramount importance. Upon success in fulfilling it is largely dependent the success of the others.

There is now a considerable body of experience in flying for vertical air survey photography, but most of this is for smaller scale mapping than that here under discussion. It will be of interest, therefore, in order to see just how exacting are the requirements for the flying for large scale work, to compare photography at the $1/20,000$ scale on a 7-in. $\times$ 7-in. plate by a 7-in. focal length lens, with that at the $1/5,000$ scale on a $8\frac{3}{4}$ -in. $\times$ $6\frac{1}{2}$ -in. plate by a 21-in. focal length lens (the latter being the present Ordnance Survey requirement). It is here necessary to explain that any pair of adjacent photographs in the same strip which has as little or less than a 50 per cent. overlap is useless, and that any two adjacent strips of photography which have as little or less than no overlap are also useless.

There are two ways of looking at this problem. First, let us suppose that the photographers have set their apparatus to obtain with a vertical photograph 60 per cent. fore and aft and 25 per cent. lateral overlap, and then let us examine the effect of random tilt. It is generally

accepted that a good survey pilot using manual control can keep his random tilt within a maximum of 2 degrees from the vertical. The average tilt will, of course, be less than this, but it is the limiting case with which we have to deal. The effect of two such maximum opposing tilts will be as follows:—

2° Opposing Tilts.	Fore and Aft Overlap.	Lateral Overlap.
	%	%
Small Scale	51	16
Large Scale	37	8
<i>Minimum allowable</i> ...	> 50	> 0

Now if these maximum random tilts could be reduced, say, to a quarter of a degree, the comparison would be as follows:—

$\frac{1}{4}^{\circ}$ Opposing Tilts.	Fore and Aft Overlap.	Lateral Overlap
	%	%
Small Scale	59	24
Large Scale	58	23
<i>Minimum allowable</i> ...	> 50	> 0

So far this comparison has served to show how far more exacting are the flying requirements, in relation to the effect of tilt upon overlap, for large scale mapping than for small scale mapping, and how much less onerous would those conditions be if random tilts were systematically reduced.

The second and more practical way of looking at this problem, and one which may make more appeal to the

economically minded, is to consider what *additional* overlaps must be continuously maintained on account of random tilts alone if the photographs are never to fall short of that minimum overlap below which they are useless. There are, of course, other considerations which will necessitate a further allowance for overlap, but at the moment we are considering only the tilt aspect of this question.

Overlaps *additional* to the Minimum to be maintained
on Account of Random Tilt.

—				Fore and Aft.	Lateral.
2° Tilts	{	Small Scale ...	...	8·6	8·6
		Large Scale ...	...	22·6	17·4
¼° Tilts	{	Small Scale ...	...	1·1	1·1
		Large Scale ...	...	2·8	2·2

This Table shows more clearly the additional allowances for overlap, which must be made on account of random tilts. The addition of about 20 per cent. of overlap in photography for large scale mapping is sufficiently serious in itself. It necessitates more exposures in each run ; closer spacing of individual runs, and therefore more flying. This is an embarrassment not only to the economics, the photography and the navigation, but also, as will be seen later, to the surveyor. Whereas, however, fore and aft overlap can be mechanically controlled so as to allow for ground speed and random tilts, lateral overlap is not susceptible to such control, and is dependent upon skill in navigation. It will be of interest, therefore, to see how nearly the ground track of the aircraft must be maintained in the two cases. The Table on p. 138 shows the amount measured on the ground that the aiming sight will depart

from the point vertically below the aircraft on account of tilt, and the equivalent loss of lateral overlap.

—		Departure from Plumb Point.	Loss of Overlap.
2° Tilts	Small Scale	Yards 135	% 4·3
	Large Scale	102	8·7
$\frac{1}{4}$ ° Tilts	Small Scale	17	0·5
	Large Scale	13	1·1

As has already been seen, the loss of overlap on account of tilt is considerably greater in large scale photography. The amount that the sight will depart from the plumb point on account of random tilts is, other things being equal, somewhat in favour of the large scale photographer ; but it must be remembered that he is aiming at altogether smaller objects, and at more accurate flying. If in each case the photographer is intending to obtain 25 per cent. lateral overlap, the amounts which he can permit himself to depart on either side from his intended ground track without losing overlap are as follows:—

Small Scale ... 488 yards.
Large Scale ... 152 yards.

Subtract from these figures those in the previous Table, and it will be seen at once that whereas the small scale photographer has nearly a quarter mile left to play with on either side of his line for *navigational* purposes, the large scale photographer has only 50 yards. Even if he could reduce his tilt to a quarter degree he has only the narrow margin of 140 yards.

To keep an aircraft along the whole of its run within a quarter mile of the selected ground track, and at the

same time maintain the aircraft on an even keel at a constant height, is itself no very easy matter, but when the limit is reduced to 140 yards the problem is in altogether a different class. It is perhaps not easy for the layman to appreciate fully the difficulty. Most of us, however, have in our youth, and much to nurse's annoyance, practised the art of walking along the kerb without either treading on the pavement or falling into the gutter. Some of us have extended the forbidden practice into maturer years. The airman's problem is even more difficult, for his aiming sight is continually swaying from the vertical with the motion of the aircraft. It is not possible for experimental purposes to impart a 2-degree sway to the solid surface of the earth, but the effect can be produced in the subject by suitable doses of alcohol. Though this analogy may appeal more readily to the imagination, it is not an experiment to be recommended. It will be quicker, and in the long run probably cheaper, to go up in an aircraft and see.

The basic problem then of the airman resolves itself into trying to stabilise his aircraft in an unstable element. The more rigorous the photographic requirements the more necessary does this become, and the more nearly he can approximate to stability the easier are all his operations. It is a problem which is not at present capable of an absolute solution, but we are tending towards a solution which should be a sufficient approximation to fulfil the more rigorous requirements of large scale mapping. There is no doubt that many remarkable performances have been put up by pilots skilled in survey flying, and it does not detract from the value of these to say that the mechanical pilot is capable of even more remarkable and consistent results. There are now several types of automatic pilot available, but not all of them attempt to solve the survey problem. The Smith's automatic pilot, originally developed under the Air Ministry, is capable of flying an aircraft in fair weather, and fair weather is the only suitable weather for survey photography, with a probable tilt of a quarter

of a degree. It has the additional advantage that direction of flight can be directly under the control of the navigator.

That this instrument has not already been more extensively used for air survey photography is probably due to the adequacy of manual control for many of the topographical and geological surveys which form the major portion of the air survey work at present undertaken. When, however, it comes into more general use as it seems to be doing, it will doubtless receive more general attention for survey purposes. The advantages of more systematically vertical photographs for topographical contouring from air photographs are very considerable. The advantages of stabilised flying for large scale air survey mapping have already been stressed. When the additional allowance for lateral overlap and, therefore, the additional flying under manual control, and the very high percentage of photographs which have now to be rejected on account of lack of overlap, excessive tilt, or faulty navigation, are taken into consideration, it would seem that the use of an automatic pilot would be an economic proposition on most air survey operations.

There remains one major flying problem which must be mentioned, and one which is peculiarly apparent in this country. Air survey photography requires a clear sky, a clear atmosphere, and a high sun. In most countries these conditions come at known periods of the year which can be forecast with some certainty. The fickle nature of our English weather is proverbial, but it may not be generally realised that in this country there are on the average only 100 to 150 flying hours on from 20 to 30 days dispersed over some six "summer" months, which are suitable for vertical air survey photography. The air surveyor has, therefore, some real cause to grouse if the Clerk of the Weather is not kind. He must stand by during the whole photographic season with his aircraft, his crew and his equipment to seize every opportunity for photography. On the other hand, once he does get going on his photographic

run, even in large scale work his instruments will photograph some 1·4 square miles per minute. It is essential, therefore, that when the weather is available he should be in a position to take full advantage of it. He must be at the top of his form, with all his gear working properly and his navigation perfect. Any device that will save wasted flights is well worth while.

THE PHOTOGRAPHIC PROBLEM.

The particular photographic requirements of the Ordnance Survey have already been stated as:—

- (a) 1/5,000 scale.
- (b) Long focal length lens.
- (c) Not less than 60 per cent. fore and aft and 10 per cent. lateral overlap.
- (d) Vertical photographs.

To these may now be added the following:—

- (e) No crabbing of photographs, *i.e.*, the leading edge of each photograph must be at right angles to the ground track of the aircraft.
- (f) Sharp definition of the detail on the photograph.
- (g) A negative giving a true and undistorted representation of the perspective conditions visible to the eye of the camera at the instant of exposure.
- (h) Enlargements from the negative to the scale of mapping.

The rôles of navigator and photographer are often doubled by one man. In many kinds of survey photography this is a satisfactory and, of course, economical arrangement. In the more rigorous conditions of large scale mapping it is not possible for one man to carry out both duties efficiently.

Before going into the air the intended lines of flight should be laid down on the map. This can be done on a photo-

graphic reduction to $2\frac{1}{2}$ -in. to the mile of the 6-in. Ordnance Survey Map. Though special features may need to be chalked up, it shows sufficient detail for navigational purposes, and it is of a convenient size. The spacing of the lines of flight must allow sufficient lateral overlap between adjacent strips of photographs to account for random tilts and navigational inexactitudes. The pilot's job is to attain the correct height, determined by the scale of photography, and, under the direction of the navigator, to bring his aircraft over the starting point of each strip on that course which will make good the required ground track. Thereafter he must maintain the aircraft on an even keel at the correct height and, under the direction of the navigator, on the correct course. It will be seen that this necessitates in the first instance either a knowledge of the speed and direction of the wind, from which the compass course can be calculated, or a knowledge of their effect upon the particular course. Though there are methods of obtaining this information by observations from the ground to the air, it can, and usually is, obtained by observation from the aircraft to the ground. From observations of the drift and air speed on any two straight flights, preferably at right angles to one another, the wind speed and direction can be deduced, and from this can be calculated the particular course to be steered, the drift to be anticipated, the ground speed, and the time interval between successive exposures. With the advantage of a detailed map of the ground, minor corrections to the calculated course can be made by a trial or dummy run along one of the strips. This dummy run serves also the useful purpose of a practical check on all the calculated data, and can if necessary be used for the direct supply of that data. The data obtained will usually hold good for several hours and can be used for all parallel strips of photography flown in the same direction.

If alternate strips are to be flown in opposite directions fresh data must be obtained for the return flights.

There is difference of opinion whether this procedure should be used. It depends mainly on the length of strip to be photographed, the time taken to turn round, and the accuracy of the navigation. I need not here enter into a discussion on the pros and cons, as each case must be treated on its merits. From the Ordnance Survey point of view, the strips need not be of great length. Six miles, which would cover four Ordnance Survey plans in an east and west direction, would be a workable minimum.

With the aircraft covering about two miles per minute the navigator has no easy task. An error of one degree in direction will take him off his track at about 60 yards per minute. Wind conditions will increase the difficulties of navigation and the errors of direction (they will not, of course, increase the deviations from the chosen line due to the same error of direction). When, to the navigator's difficulties are added the random tilts of the aircraft, which makes the ground appear to progress across his aiming sight with a most uncertain motion, the speed at which the ground passes beneath him, and the necessity for telling the pilot what to do under difficult conditions of communication, it will be seen that not only is his task onerous but that he cannot possibly do it efficiently if he has also to work and aim the camera. It is in the navigation that the value of the automatic pilot, quite apart from its ability to reduce the tilt of the photograph, is particularly apparent. It is so remarkable that no one who has not flown with it could readily believe the effect. The ground appears to pass across the aiming sight in a comparatively steady stream, and the true ground track can be more readily determined. The navigator, too, can himself make small adjustments to the direction of the aircraft without reference to the pilot ; for it can be arranged for him to have the azimuth controls of the automatic pilot under his own hand, and with this he can make a flat turn without upsetting the flying trim.

Meanwhile the photographer has his duties to perform.

Before going up he must see that his camera levels are in adjustment, that his apparatus is in working order, and that he has sufficient film in his magazine. Before each photographic run he must set the angle of drift on the camera mounting and the exposure interval on the control mechanism. The angle of drift is found, as already explained, by the navigator, or the photographer may have a separate sight with which to find it by direct observation to the ground. It must be set on the camera mounting in order to prevent crabbing, or more simply to keep the camera oriented in the direction of the ground track of the aircraft, which is not necessarily the direction in which the aircraft is pointing. The exposure interval determines the fore and aft overlap, and can be set on the control, which then automatically releases the shutter at the required interval. It is dependent upon the ground speed and the allowance necessary for random tilt. The former may be calculated from the air speed of the aircraft and from the wind speed and direction, which has already been determined by the navigator ; or it may be found by direct observation to the ground. The time interval for a 60 per cent. fore and aft overlap at a 100 miles per hour ground speed, under our particular conditions, is 8.0 seconds, one second being equivalent to about 5 per cent. loss of overlap. The maximum allowance necessary for random tilts is minus 1.4 seconds for automatic flying, and minus 5.0 seconds for manual flying. The allowance necessary for variation of ground height varies with the nature of the ground, and is usually insignificant.

The photographer must also level his camera as soon as the aircraft has been brought into photographic trim, and he must continually watch his levels during the photographic run, and make such alterations to the levelment as may be necessary on account of systematic alterations in the flying trim. If the levelment is properly done in the first instance, and if the aircraft is well flown, but little alteration of levelment should be necessary. A constant

watch, however, is essential so that the mean pointing of the camera axis shall be vertical, and no constant tilts introduced to the pictures. If successive strips are flown in opposite directions a complete resetting of all the adjustments is necessary at every turn round ; a moment, it will be noticed, at which the navigator is already fully occupied. I need not further stress the difficulty of doubling the rôles of navigator and photographer in this rigorous type of photography.

On completion of the day's photography the film must be developed and rough contact prints must be taken off so that the overlap and definition can be examined. Any loss of the necessary overlap or bad definition will mean that all or part of the strip must be re-photographed.

It is most important that the developing processes should be carried out with care ; not only with a view to getting the best picture out of the negative, but also in order to avoid unnecessary distortion in the film base. As will be seen later, part of the technique of revision from photographs is dependent upon lines radial from the centre of the picture representing true direction on the ground. Modern film base is comparatively free from distortion if properly handled. It is immaterial whether it shrinks or expands, provided it does so evenly in all directions. If stresses are set up in the film during any of the processes through which it passes, and particularly when it is wet, distortions of shape are likely to occur which may seriously affect the value of the photograph. The same, of course, is true of the contact prints and enlargements taken from a negative, and great care in handling is essential.

A word of warning is necessary on shutter distortion. The focal plane shutter consists of a variable sized slit travelling across the plate near the focal plane. Though this is capable of exposures fast enough to give good definition, the exposure is not simultaneous over the whole area of the plate. The minimum time which the slit takes to travel across the focal plane is about one-tenth of a

second. With the aircraft travelling at about 160 feet per second it will be seen that the detail on one side of the exposure may be moved the equivalent of 16 feet on the ground (that is 0.08 inches at the $1/2,500$ scale) in relation to the detail on the opposite side of the exposure, whilst the details on the remaining two sides of the exposure are unmoved in relation to one another. Such a distortion is not tolerable for mapping at this scale. Moreover, further and unpredictable distortion may be introduced by such tilt or changes of the direction of the camera axis as may take place within the one-tenth of a second during which the slit is travelling across the focal plane. Fortunately the modern louvre shutter can give speeds fast enough for good definition and it exposes the whole area of the plate simultaneously.

I am afraid I must refer once more to the somewhat dismal question of the English weather. Even on days when the sky is clear and otherwise entirely suitable for air photography, there are mists and haze which hang about the surface of our island and are sufficiently dense to spoil the definition of the photograph and obscure the details so much as to render them useless for survey purposes. This has been particularly noticeable in the Midlands this summer. Very remarkable results have been obtained by infra-red photography in piercing haze and producing a clear picture of detail which is not visible to other forms of photography. Unfortunately the speeds obtainable with these emulsions are not at present fast enough to meet the requirements of large scale survey photography. Considerable increases of speed have been obtained in the last few years, and it is to be hoped that further increases will be obtainable. No doubt the use of infra-red film will present the survey photographer with difficulties, and the change, and sometimes complete reversal, of tone values will present the surveyor with new problems in interpretation. But there should be no insuperable difficulty in overcoming these. If the infra-red

photograph could see through cloud and rain we should indeed be in a photographic paradise. That may be a pleasant flight of fancy, but at present it is an unprofitable speculation. At present the best film for our country is a panchromatic emulsion with a K2 filter.

When the film is available contact prints and enlargements have to be taken off. With a long focal length lens the illumination over the whole plate is usually fairly even, though differences in the tone values of the objects photographed may necessitate the shading or holding back of the lighter portions of the film while the darker are brought up. This shading has to be done by hand. The enlargements must be made from the scale of the photograph to that of the plan, and in order to obtain this enlargement factor it is necessary to measure distances on the photograph and on the plan between points of detail which appear on both. The disappearance of old detail from the ground is no great embarrassment. If there are no great changes in ground height and if the aircraft has maintained a constant altitude, a whole strip of photographs can be put through the enlarger at the same enlargement factor. During enlargement hand shading is again necessary, and careful handling of the material is essential in order to prevent distortion in the print. It will give some idea of the magnitude of the photographic undertaking, that even with the optimum overlaps of 60 per cent. fore and aft and 10 per cent. lateral, nearly 8 exposures are required per square mile. In actual practice with manual control, 14 exposures have been necessary. This increase of 75 per cent. has been caused by additional overlap allowance for random tilts and difficulties of navigation, and it does not take into account useless photography wasted because of excessive tilt, lack of overlap, poor definition, and similar causes.

I have now dealt in somewhat general terms, with the flying and photographic problems of large scale air mapping. Though I have not given a detailed description

of all the processes, I hope that what I have said will give the reader a general idea of the problems involved before we pass on to consider in rather more detail the uses to which the photographs are put by the surveyor.

THE REVISION PROBLEM.

The method of revising the plans from photographs, which will now be explained in detail, may be summarised as the orientation of each photograph or group of photographs by the radial line assumption* into its correct position in relation to the old detail on the plans ; the intersection from these photographs of such control points as may be required ; and the supplying of detail by rectification between the control points.

When the photographs are received in the Plotting Office they are indexed and stored in accordance with the plan upon which their principal points fall. This provides a convenient means of referencing and storing. The next process is to compile a key map showing what work has to be undertaken and what photographs must be used for it. This is done at the scale of $2\frac{1}{2}$ -ins. to the mile ; the basic map being a photographic reduction of the 6-in. Ordnance Survey Map shows the state of the ground after the last 25-in. revision. The principal points of the photographs are plotted and joined up so as to show the flight lines. The new features which have appeared on the ground since the last revision are known as "improvements." From an examination of the photographs the "improvements" are marked up in chalk on the key map, which now shows what work has to be undertaken and serves also as an index to the plans and to the photographs.

* I have dealt only very briefly below with the radial assumption, but sufficiently, I hope, for the general reader to follow the arguments. Further information on this subject is contained in *Surveying from Air Photographs* by M. Hotine (Constable & Co.), and in "Professional Papers of the Air Survey Committee, No. 3," H.M.S.O.

The men in the Plotting Office are organised in sections, each with a superintendent and assistant, and from six to eight air revisers. The first duty of the superintendent is to provide the control and other data necessary for the air reviser. The provision of the control is dependent upon the radial assumption. In any photograph the distortions due to tilt are radial from the isocentre, and the distortions due to height are radial from the plumb point. In a vertical photograph the plumb point and the isocentre coincide with the *principal point of the photograph, and lines drawn from it on the photograph represent true directions on the ground. Should the photograph be tilted, lines radial from the principal point no longer represent true directions on the ground, but it can be shown that provided the tilts are small the errors introduced are not of plottable significance and that it is safe to assume that the lines radial from the principal point of the photograph represent true direction on the ground. For revision purposes, where the ground control provided by the old detail is plentiful and closely spaced, tilts up to a maximum of two degrees can be tolerated. The next process, therefore, is marking the base lines on the photographs. This consists of drawing on the photographs lines radial from the principal point through the image on the photograph of the principal points of the adjacent photographs. The orientation for this purpose is done in a precise stereoscope.

The next process is to choose control points.

- (1) "Ground Control Points." Those points of old detail appearing both on the existing plans and on the photograph, which are to serve as ground control and enable the photograph, or group of

* The principal point of the photograph, which the general reader may take to be the centre of the photograph, is the foot of the perpendicular from the internal perspective centre to the plane of the photograph. It is determined for the particular camera in use, and can thereafter be immediately marked up on any photograph. The isocentre and the plumb point cannot be so determined, and are dependent upon the unknown tilt of the camera.

photographs, to be oriented together into their correct position.

- (2) "Slope Control Points." Points to serve as the control between which the various facets of the countryside may be treated within certain limits as a plane surface, and be rectified in the epidiascope. These points are selected by stereoscopic examination of overlapping photographs and with the aid of the 6-in. contoured map. They will fall at the natural changes of ground slopes and will form the apices of triangular areas which will be rectified. "Check Points" are also selected near the centres of the triangles and are used as a check upon the rectification.
- (3) "Minor Control Points." Such further points as may be necessary to bind together adjacent photographs in their relatively correct positions. These points must appear clearly on the photographs, but they need not appear on the original plan, or indeed even be points which require to be mapped.

Each of the points chosen for these various functions may fulfil more than one of those functions and must be selected with due regard to convenience and economy of labour, so that each fulfils as many functions as possible.

The selected points must now be stereoscopically identified and marked up on all the adjacent photographs on which their images appear. It will be noticed that all points will appear on at least two, and some on three photographs in the same strip, while in the lateral overlap between strips one point may appear on as many as six photographs. Advantage must be taken of this to secure economy of control points and sympathy between adjacent strips of photography.

The superintendent is now ready to transfer the control to the plan. Over each photograph he places a piece of transparent Kodatrace, known as the "minor control

"trace." On this he traces off the principal point and base line directions, and draws lines radial from the principal point through all his chosen control points. It will now be seen that any one "minor control trace," which contains sufficient radial lines to points of old detail, can be oriented into its correct position by shifting it about until all the radial lines pass simultaneously through their respective points of old detail on the plan. This amounts to a simple trial and error resection. It will also be seen that if the neighbouring "minor control trace," which overlaps the first by 60 per cent., is also orientated in the same way into its correct position on the plan, any new control points which lie in the common overlap will be automatically intersected by their respective radial lines from the two principal points, and can, therefore, be pricked through on to the plan in their correct positions. This is the principle underlying the provision of control points, but the adjustment is not always quite so simple in practice, particularly when some of the photographs have few or no suitable points of old detail.

The adjustment, therefore, is carried out as a whole to cover a convenient area and encompass complete "improvements," so that these may be assimilated to and be in sympathy with all the surrounding old detail. Such areas may lie in one plan or in parts of two or more. The "minor control trace" covering the most old detail is first laid down and oriented. The second "minor control trace" is oriented to the first upon the common base line direction, and can be moved in or out along this direction until its radial lines pass through the plan positions of detail points. The third can be treated in the same way, and if it has no radial lines to detail points, those new points already intersected on the two previous "minor control traces" can now be used. The process of laying down traces in this way can be continued until more old detail is met with. At this moment some adjustment in scale and orientation may be necessary so as to bring the whole strip

into sympathy between the outlying points of old detail. At the same time the adjacent strip may have to be laid down in the same way, and the points in the common lateral overlap adjusted so as to give the best possible intersections.

It will be seen that we now have a complete series of "minor control traces" laid down in sympathy with all the surrounding old detail, and all new control points are automatically intersected by at least two, and often by three or even as many as six, rays. These can now be pricked through on to the plan.

It is important to notice that this method also provides an automatic check on all points of old detail that have been used. Any point that is in error on the old plan is immediately discernible, for the radial lines will not go through it. Without further ado its correct position can be pricked through on to the plan, and that bugbear, the old error, which causes the ground surveyor so much difficulty, uncertainty, and loss of time, can be eliminated. It is worth pausing here a moment to consider the difference between the bird's eye view of the camera and the worm's eye view of the ground surveyor. To get his lines and intersections the latter is dependent upon intervisibility between points on the ground. It is impossible that all old detail can be so advantageously placed as to be available for use; in practice only a small percentage is so placed. He may, after starting from some erroneous point, proceed some considerable way upon his work before some direction or measurement fails to check out. He must then obtain an independent check in order to establish with certainty where the error lies. That takes time and is not always easy. Then much of his work is to do again. It may even be that his faulty origin remains undetected and the error then propagates itself into all the new work and leaves a far more difficult problem to be unravelled at the next revision. The camera, on the other hand, has no such problems of intervisibility. It sees the whole panorama

intact, though to be sure it has its own difficulties of seeing at all in bad weather.

The next step in our work is to prepare the document upon which the air reviser is to do his part. This is called the "field trace," and is exactly the same as that used by a ground reviser. It consists of a sixth part of the plan pulled in red on tracing paper from the plate of the last edition; and each trace overlaps its neighbours by a convenient amount so that the new work to be added can be carried across the joins without an artificial dividing line.

The superintendent already has all his data on the plan, and such of this as is necessary he now transfers to the field trace. All the points used by the superintendents are not necessarily required by the air reviser. The slope control points, the check points, and the triangles to be used for rectification, are transferred and marked up in distinctive colours. Items requiring special attention are indicated, and the areas where no revision is necessary and where improvements have taken place are shown. The field trace and the photographs are then passed to the air reviser, who is now ready to commence his work.

The duty of the air reviser is the stereoscopic interpretation of the details on the photograph, and the transfer of those details to his field trace. The single photograph being a flat picture of the solid ground and the solid objects on its surface, can only be a flat representation of the tone values received on the photographic plate through the *single* eye of the camera. The interpretation of the true ground position of the solid objects on the earth, and indeed the interpretation of the objects themselves, is by no means easy on this flat representation. Shadows can easily be mistaken for the objects themselves, and this will introduce errors which are too large to be tolerated at this scale of mapping. Differences of tone value, too, will make the interpretation of exact position extremely difficult. If, however, two overlapping photographs are examined simultaneously in a stereoscope, the observer sees a solid

impression of the earth and the objects on it, and this impression is as though he had one eye at each successive camera station, which are some 360 yards apart. To appreciate the value of such a stereoscopic view it must be seen. Many of my readers have no doubt examined air photographs in this way. Those who have not must accept the fact that identification and interpretation of detail is made far easier and more exact by this means. It is an art, however, which requires some little practice to master, but once mastered it is quite simple. It is essential therefore that the air reviser should be well practiced in this art and that he should use the stereoscope for all his interpretation.

As he proceeds with his interpretation the air reviser marks up on the photographs such detail as he will use in the epidiascope. The process of marking the photograph takes some time, and economy in the choice of detail to be so marked is desirable, for it is by no means necessary to mark up all the details which have to be mapped. The air reviser confines himself as far as possible to old detail which he will use in the epidiascope, to the main framework of symmetrical blocks of buildings and road lay-outs, to such details as will in fact enable him to complete the remainder at a later stage by measurements and directions from the photographs themselves, and to such details as are not entirely clear on the single photograph. He now proceeds to rectify each triangle in turn and transfers the detail to the field trace.

The epidiascope used for rectification consists of a flat glass tracing board, below which is a cone carrying a lens. The lens is mounted on a slow motion focussing sleeve to allow for small changes of scale. Below the lens is the copyboard to carry the photograph, which is held in position on the copyboard beneath plate glass of the same thickness as the tracing board. The copyboard is supported in gymbals, and is capable of being tilted about two axes coincident with the surface of the photograph. The tilts are

operated from above the tracing board and have slow motion screws. The photograph is illuminated from outside by a beam of light projected through the side of the epidiascope. The beam of light passes through a trough of water, and this arrangement prevents any part of the instrument or the photograph being heated up, and so avoids distortions. The relation between the tracing board, the lens at its central focussing position, and the copyboard, is that required for 1:1 enlargement.

This arrangement may not be theoretically the most desirable to deal with all types of photographs, but it has the enormous practical advantage of being easy and cheap to manufacture, simple to operate, and capable of doing the job for which it is designed. In practice the lack of definition introduced by the small changes of scale and the small tilts necessary is entirely tolerable.

It is with this instrument that the air reviser transfers the details from the photograph to the field traces. He deals in turn with each triangle, the apices of which are slope control points. The image of the photograph on the copyboard is projected up on to the transparent field trace on the tracing board. By suitable adjustment of his focus and tilts he brings the image of the slope control points into coincidence with their true positions on the field trace, and then draws in pencil on the field trace such details of the photograph as he requires. Here again we are dealing with an approximation, for it will be noticed that this three-point method of rectification is not theoretically correct. The check points in the triangle, however, serve to show immediately whether any *plottable* error is being introduced. If it is, more control must be supplied and the triangles of rectification made smaller. In actual practice the more broken the nature of the country the more control is necessary. The method of choosing the control points looks after this aspect of the problem, and it is seldom that an air reviser has to apply to his superintendent for further control points.

Having taken off in pencil such details as he requires, the air surveyor proceeds to complete his field trace in ink. With the photographs always in front of him, he inks in his work and completes it by measurements from the photographs where necessary. He puts in nothing which he cannot identify and plot with certainty from the photographs. Such doubtful areas he rings on the trace for the attention of the ground examiner. Any detail of which he is fairly sure but not entirely confident he may leave in pencil as a guide to the ground examiner. Having completed his trace he hands it back to the superintendent.

The superintendent compares the trace with the photographs, and this he does on a tracing table, a simple glass-topped table illuminated from below. On this any gross errors or omissions are immediately apparent. Radial directions to test the correct alignment of detail are also used at this stage as an independent check. A proportion also of the epidiascope settings are checked, and the trace generally looked over for penmanship and completeness.

The field traces are now sent to the field for examination and completion on the ground. The field parties are organised in the usual Ordnance Survey manner, with three or four men under a field superintendent. The ground examination is done broadly on the lines of normal "final revision," which need not here be described in detail. Suffice it to say that the ground examiner checks the work supplied by the air reviser, adds such further improvements as have occurred since the photographs were taken, completes those details which the air reviser has been unable to plot from the photographs and to which he had drawn attention on the trace, collects new and checks old names, examines level bench marks, and generally completes the trace to Ordnance Survey standard.

The field superintendent makes a final ground examination of his men's work. He merges the boundaries, sees that edges have been compared, and that the traces are generally up to standard.

The field documents are then sent in to the office, where the normal processes are continued; trace examination, fair drawing of the plan, typing of names, ornament and levels, area computation and typing, boundary examinations, plan examinations, reproduction, proving and printing; and, finally, there issues the Ordnance Survey plan.

Though we have as yet had very little experience of the ground examination of the air work, the accuracy of the air photo plotting is so far proving very satisfactory. None of the errors brought to light are attributable to the *methods* of plotting adopted, but can be traced to lack of training or lack of experience in the operatives themselves. This is a trouble which is inherent in any form of survey, though, of course, the class of error to which men may be most liable will vary with different survey methods, and steps can be taken to introduce the necessary checks. The trouble does not appear to apply any more forcibly to air revision than to ground revision, and we may look forward to further improvement both in accuracy and speed as the men gain further experience. Indeed, this is already becoming apparent.

Having described the method used by the Ordnance Survey for revision from air photographs, we may now consider some comparisons between the air method and the established ground methods. In the first place there is output. The long-established and careful system of recording the dates of and the time taken in every stage of the work, and of classifying each man's work in relation to the average time taken by a man skilled in that work, has provided a large volume of reliable data based on long experience from which normal speed and output can be ascertained. There is no such background of long experience in which our recent experiments in air revision can be seen in perspective; and as the classification of "normal progress" is a complicated matter, dependent upon and varying with the many different types of town and country surveyed, I give these figures with some reserve and not as

a final conclusion. We have, however, sufficient experience of air methods to feel confident that the figures are a sufficient guide to future developments.

On the average an air reviser can "supply" about ten acres of "improvements" per day. A new entrant, after being trained in draughtsmanship, can learn the work and nearly reach this output in about six months. A man with experience in ground revision can learn the work more quickly, he is naturally more at home in it, and his output is on the whole better. It is desirable that as far as possible the air reviser should have experience in ground revision. Unfortunately most of our experienced ground revisers are now required to take charge of sections in the field.

The ground examination takes about the same time as the plotting from the photographs in the office, though this figure is not yet very firmly established. Here again the new entrant recently trained in normal ground methods finds, through lack of experience, some difficulty in carrying out this work expeditiously, and it comes more easily to the experienced man. It is desirable that as far as possible the ground examiner should have some knowledge of air revision.

In "open" work—rural areas where little or no improvements have taken place since the last revision—the air reviser may take only an hour or two to complete his work. The ground examiner, however, will take just as long as though he were revising the trace by normal ground methods, and as the ground must be visited in any case the air photograph provides only negative information, which if it cost practically nothing might be useful as a reconnaissance. In a trace entirely covered by new improvements the air revision and ground examination, including the final examination, would together take on the average 42 days. By ground methods, however, quite apart from such trigonometrical control that would have to be provided, such a trace would take on the average 64 days, including

final revision. Here is the large saving in time of 132 days per plan,* which can be effected by air photography, and provided the photographs can be supplied for less than the cost of 132 days' work it is also a saving in cost. Very seldom, however, do the plans to be revised lie at either of these two extremes, and between the two there is a point at which the speed by the two methods is the same. At present this seems to lie near the plan, which would take about 50 days to revise on the ground. With photography costing, say, £5 per square mile, not many days' work need to be saved before it becomes an economical proposition—provided always that the photographs can be supplied at the time they are required. With a variety of special revision programmes before us, and the greater expense of photographing scattered plans, the choice of areas to be revised by air methods is not easy.

Another comparison to which I should like to draw attention is the difficulty presented to the surveyor by the abandonment of the old rectangular lay-outs for housing estates. The modern housing estate is seldom on these lines, but is more often laid out in an artistic manner with pleasant curves, houses set back from one another and at varying angles, with gardens of different sizes and shapes. This is all to the good from the dweller's point of view, but it adds enormously to the work of the ground surveyor, who must rely on straight lines, intersections, and sometimes offsets, for his surveying. Here the bird's eye view of the camera is of great value, for though there are some added difficulties in this type of work for the air reviser, they are by no means in the same proportion to those of the ground reviser. In the same way curved roads and winding streams are far easier and, indeed, I think, sometimes more accurately surveyed from the air. Changes that may have taken place in them, too, are far more apparent from the photograph than from the ground.

A further advantage of air revision is the ease of organ-

* A plan is six traces and covers one and a half square miles.

isation and supervision. In the office about eight men can be efficiently supervised by a superintendent. Their difficulties can be immediately attended to. They can work efficiently and often more happily in wet weather. They need neither tape boys to assist them, nor travelling expenses.

On the other hand, the details on the photograph are often obscured by overhanging trees. We have not so far had any serious difficulties with this, even in the limited rural areas of which we have experience. Where difficulties occur it is usually possible to identify stereoscopically sufficient old detail for control and to provide sufficient new detail to be useful as a help to the ground examiner. Trees, moreover, do not usually appear in any quantity in new housing estates to which air methods are best suited.

The eaves of houses present another problem. The eave of a normal dwelling-house, however, is usually about a foot, and a standard allowance is made for this in penning up the photographs. It is seldom that an eave departs far enough from this standard size to introduce a plottable error at the scale. An excessively large eave, though rare, is an object which the ground examiner would naturally look out for ; whilst a house with no eaves is usually apparent on the photograph.

The height displacement, or overhang of buildings due to their distance from the plumb point of the photographs, is a further problem. With a 21-in. focal length lens the height displacement of a normal dwelling-house is hardly plottable if it lies within about three inches of the centre of the enlarged photograph. Beyond this limit the footings of the house commence to become visible on the side nearest the plumb point of the photograph, and this will occur when the displacement exceeds the eave overhang. The footings themselves can then be used, while on the reverse side of the house an allowance equal to the visible displacement plus an allowance for both eaves must be made. The height displacement for 25 feet of height at 6 inches from the centre

of the photograph is 6 links, and a 2-degree tilt will only alter this by 1 link, so that the allowances are within manageable limits. As the displacements for other heights are in proportion, the taller buildings present a similar problem, and in both cases the key to the solution is in the distance of the image from the plumb point. This may sound complicated, but is not difficult of practical application.

There still remain certain details, such as wire fences, which cannot be easily identified on the photographs, and are sometimes quite invisible. These, however, are not numerous, and such an omission should be immediately apparent to the ground examiner.

None of these difficulties affects the ground reviser. He can see beneath trees, and often a trunk will make a useful point of reference. He measures to the footings of houses and does not even notice the eaves. The houses (we hope) all appear to stand upright, and he cannot fail to see the wire fences on which he so often tears his trousers. When, however, the potentialities of the aerial camera are taken into consideration, it will be realised that here is an instrument of which the surveyor must learn to make full and adequate use, in its proper place amongst his other instruments.

FUTURE PROBLEMS.

In conclusion I should like to consider briefly some of the applications of air photography which may prove to be useful to Ordnance Survey in the future. No survey can last for ever, and the 25-in. national survey is no exception. This is not to say that its usefulness will suddenly vanish, but that at some moment it will be necessary to commence and gradually complete an extensive overhaul of the fabric. It is becoming increasingly apparent that that moment is fast approaching. The enormous changes which have taken place on the face of the country without having been recorded on the 25-in. plans is but one of the

which it may be possible to put them. In any extensive overhaul of the 25-in. plans it will be necessary to check old detail which has not been moved on the ground to ensure not only that it is of sufficient accuracy to warrant its incorporation in new work, but also to enable that incorporation to be done so that the old detail is brought into sympathy with the new trigonometrical control. Such a check, if carried out on the ground, would, in effect, amount to a complete re-survey. As has already been seen, the air photograph has considerable possibilities in this direction. Exactly how the work would be done has not yet been considered in detail, but it is evident that it is worth careful investigation.

If any programme of systematic photography of the whole country over a term of years is ever undertaken, there is little doubt that many uses for the photographs, other than those to which the Ordnance Survey could put them, will be found. Before any such programme could be initiated there are several matters to be determined. Amongst the more important of these are the economic advantages of such a programme, the organisation required to put it into effect, and whether in our English climate it is sufficiently certain that the photographs can be made available when required without being themselves unduly out of date.